Research Note

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CULTURAL TREATMENTS STIMULATE GROWTH OF WESTERN WHITE PINE SEEDLINGS

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ABSTRACT

An experiment was conducted to determine the effectiveness of cultural treatments (cultivating, fertilizing, and watering in all possible combinations) in stimulating growth rate and inducing strobilus formation in western white pine seedlings in northern Idaho. Although strobilus production was negligible, striking differences in total height and diameter at 12 inches above the ground were attributed to the cultural treatments. The combined three-factor treatment was most effective in stimulating height and diameter growth. Cultivation was the most effective single treatment and the most effective component of double treatments, particularly in stimulating diameter growth. The use of these cultural treatments is a promising method of developing seed orchard trees of sufficient size and vigor to bear large cone crops.

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INTRODUCTION

Foresters recognize that the growth of seedlings receiving some kind of cultural treatment typically would be greater than that of untreated seedlings. Only in gardens, arboreta, small private tracts, seed orchards, or seed production areas, however, can intensive care ordinarily be given to individual trees. Within a few years approximately 100 acres of western white pine seed orchards will be established to produce seed for planting stock resistant to the blister rust fungus, Cronartium ribicola Fischer. Thus, research was initiated to determine what kinds and levels of cultural treatments are most efficient in promoting growth and strobilus production. In seed orchards it is not only important that trees bear flowers at an early age, but that they attain a size and degree of branching complexity adequate for production of large quantities of cones.

LITERATURE REVIEW

From the vast amount of experience and literature in agriculture, we know that cultural treatments (fertilizing, watering, and cultivating) generally improve growth and productivity of crop plants. Since we also assume this to be true with trees, the question becomes primarily one of kind and level of treatment which will maximize growth and stimulate strobilus production.

The effects of fertilizer upon forest tree seedlings have been investigated from many standpoints and no attempt is made to summarize this literature. Major contributions to fertilization literature were cited by Barnes and Bingham (1963). Forest fertilization has shown both positive and negative results in experiments with various tree species to stimulate growth and/or seed production (Leyton 1958; Austin and Strand 1960; Laurie 1960; Stoate et al. 1961; Swan 1961; Walters, Soos, and Haddock 1961), and generalizations about its effectiveness must always be qualified.

Irrigation and cultivation are also important cultural practices in agriculture and horticulture. They are known to stimulate vegetative growth and fruitfulness, but as yet little information is available of their effects on grafts or seedlings in tree seed orchards. Smith (1961) reported excellent growth of loblolly and slash pines which had been cultivated and fertilized. Though differences between fertilized and unfertilized trees were not significant, the rapid growth was attributed largely to annual machine and hand cultivation. Hughes and Jackson (1962) studied the effects of various fertilizer regimes upon growth of young slash pines in a plantation in south Georgia. Most fertilizer treatments failed to stimulate growth significantly in comparison to the controls. However, a comparison was made with an adjoining uncultivated plantation. Uncultivated trees took 4 years to reach a height of 61 inches which was attained by cultivated, unfertilized seedlings in 2 years. Aird (1962) found that growth of poplar cuttings was two to three times greater with cultivation than without.

Mosher (1960) studied irrigation and fertilization of 90-year-old ponderosa pine in northeastern Washington. After 2 years of irrigation and one season of

fertilization, radial growth of trees in irrigated plots was over 100 percent faster, while radial growth on fertilized but nonirrigated plots was only 29 percent faster than trees receiving no treatment.

MATERIALS AND METHODS

Four randomized blocks each with 10 planting spots (20-foot×20-foot spacing) were installed in 1955 on a cleared plot along Emerald Creek near Clarkia, Idaho, St. Joe National Forest, ($NE\frac{1}{4}NW\frac{1}{4}$, sec. 4, T. 42 N., R. 1 E., Latah County, Idaho). The elevation is approximately 2,800 feet. The original stand of young pole-size trees (western white pine, larch, and lodgepole pine) was cleared with a bulldozer in the fall of 1953. Debris was windrowed and the flash fuels burned in the fall of 1954. The site is level, moderately dry, and the soil is generally a deep sandy loam, relatively free of rock.

At each spot two 6-year-old seedlings were planted on either side of a stake marking the planting spot. Eight of the planting spots were used to test the following treatments:

1. Cultivating (C)
2. Fertilizing (F)
3. Watering (W)
4. Cultivating and Fertilizing (CF)
5. Cultivating and Watering (CW)
6. Fertilizing and Watering (FW)
7. Cultivating, Fertilizing, and Watering (CFW)
8. No Treatment (NT)

Grafts of local intraspecific western white pine crosses on eastern × western white pine hybrid root stocks were planted at the two remaining spots in each block.

A 14.3:14.3:14.3 formula fertilizer was applied annually in the spring during the period 1956-1960 (table 1). Fertilizer was spread evenly in a circle around the base of each tree. Soil around each tree was cultivated at the time of fertilization and again at each watering in the summer. Trees were watered one to three times during the summer, depending on weather and soil moisture conditions. Each tree received about 24 gallons of water at each application.

Table 1.--Rate of application of a 14.3:14.3:14.3 fertilizer, 1956-1960, Emerald Creek Plot, St. Joe National Forest

Year	Actual fertilizer applied	Radius of circle	Fertilizer per acre				
			Elemental N	P_2O_5	Elemental P	K_2O	Elemental K
	Pounds	Inches	Pounds				
1956-57	$\frac{1}{2}$	18	441	441	192	441	366
1958-59	1	18	882	882	385	882	732
1960	3	24	1,487	1,487	648	1,487	1,234

RESULTS

Only 52 of the 80 trees planted were living in 1960. Nearly all mortality was attributable to pocket gophers, although heavy mortality at the fertilizer-only spots (five trees of eight died) probably was due indirectly to the treatment itself. Fertilizer greatly increased grass and weed competition around these trees.

Only two trees flowered during the 6-year treatment period. One tree receiving CFW treatment produced a single female strobilus in 1958 (tree age 9 years). This tree was later severed at the root collar by gophers and died in 1959. The other tree at the same planting spot produced two male strobili clusters in 1958, 14 male clusters in 1959, and three clusters in 1961.

Highly significant differences in total height and stem diameter at 12 inches above the ground were attributable to cultural treatments (figs. 1, 2, and 3). Duncan's multiple range test (Duncan 1955) was used to determine significant ($P < 0.05$) differences between treatments (figs. 1 and 2).

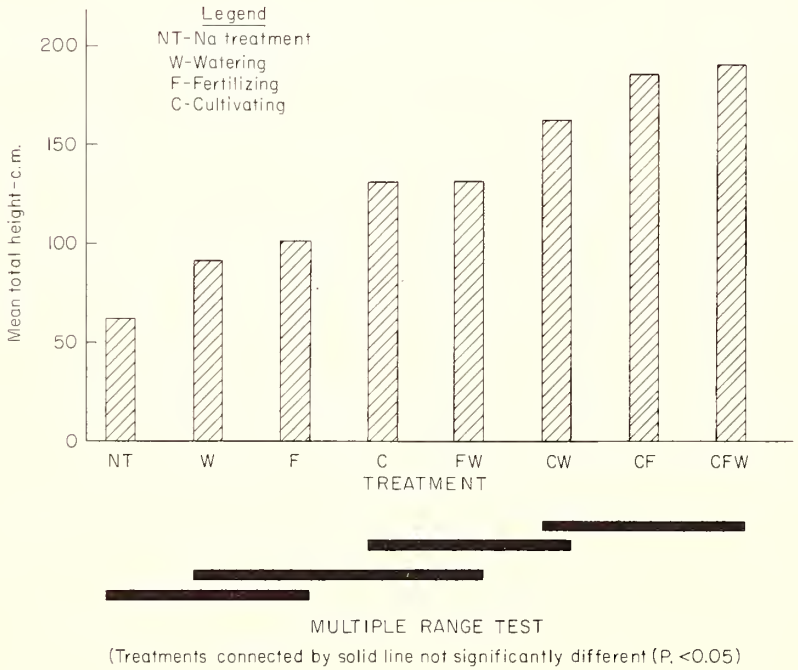

Figure 1. -- Effect of cultural treatment upon total height growth of western white pine seedlings.

Triple treatment (CFW) was most effective in stimulating height growth, but was not significantly different from two double treatments each including cultivation (CW, CF). Cultivation was the most effective single treatment. No significant differences were found in total height between untreated trees and trees receiving either water or fertilizer treatment alone.

Response to treatments was greater for diameter than for height (figs. 1 and 2). Again, CFW treatment was most effective and not significantly different from the CW treatment. Cultivation was the most potent single treatment. Each of the four more effective treatments included cultivation.

Because of the inconvenience and expense of irrigation, the frequency of applications was held to a minimum. With more liberal application, the effects of this treatment might have been greater.

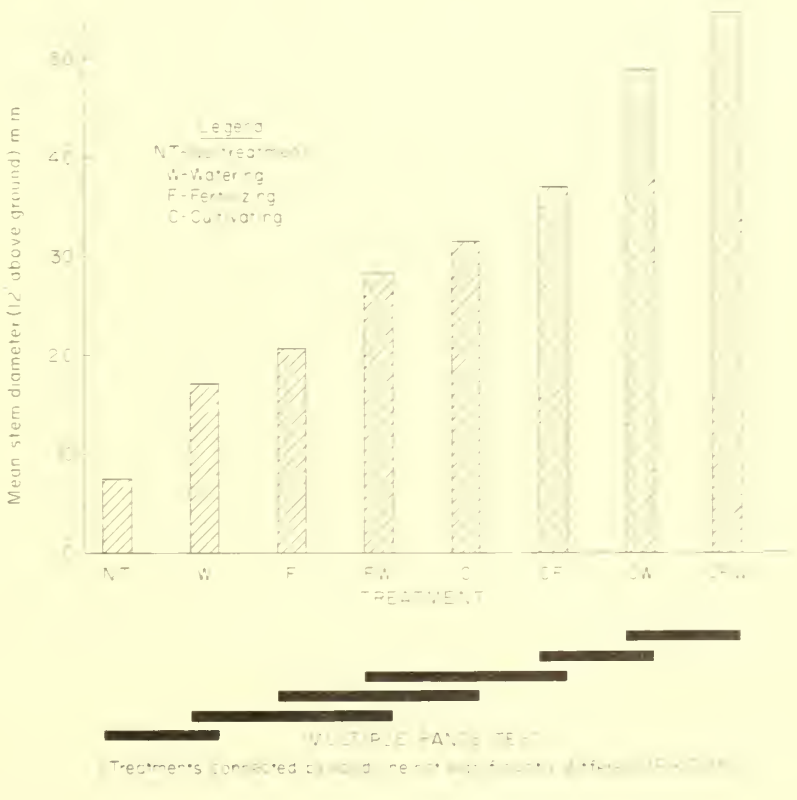

Figure 2. -- Effect of cultural treatment upon diameter growth of western white pine seedlings.

Figure 3.--The trees in the background (average height, 6.8 feet) were cultivated and fertilized five consecutive growing seasons. The one in the foreground (average height, 1.8 feet) received no treatment.

DISCUSSION

Previous experiments employing top grafting and fertilization, cultivation, and watering failed to markedly induce or stimulate flowering of western white pine trees (Barnes and Bingham 1963). Although flowering has not been induced by any cultural treatment employed in this experiment, the excellent vigor and form exhibited by trees receiving the CFW treatment is encouraging. In seed orchards, once flowering begins, the major emphasis probably will be upon the size and shape of the tree. Ultimately we anticipate greater success in stimulating strobilus production through use of cultural treatments rather than by strangulation, girdling, or other treatments which would injure the graft or seedling.

Experience with a breeding arboretum, composed of twice-transplanted seedlings of proven blister rust resistance, has given further encouragement in the use of cultural treatments. Of 764 6-year-old seedlings transplanted from field plots to the arboretum near Moscow, Idaho, in 1957, 16.4 percent had flowered (nearly all female) through the 1962 growing season (Bingham).[2] Most abundant flowering occurred in 1961 when seedlings were in their tenth growing season. We recognize, however, that although these trees received annual cultivation, watering, and fertilization, other environmental factors such as transplanting, soil, and climatic conditions, etc. may have been instrumental in hastening strobilus production.

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[2] Bingham, R. T. (In preparation for publication). Precocious flowering in western white pine. Intermountain Forest & Range Experiment Station Research Note.

Wareing (1959) found that the attainment of a certain absolute size was a primary factor in determining the transition to the adult (physiologically mature) condition. If size is an important determinant of the adult condition in western white pine, appropriate cultural treatments should indirectly hasten flowering. In addition, the trees would have sufficient size and strength to bear relatively large cone crops.

Though fertilizing and watering were effective in this experiment, cultivation is apparently the simplest and most effective way of increasing the size of western white pine seedlings. Whether it is the most practical and effective single treatment in seed orchards having thousands of individuals remains to be seen.

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